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Safe Arthroscopic Approaches for Epicondylitis: Topographic-Anatomical Study

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Background. Arthroscopic methods of diagnosis and treatment of elbow diseases have not yet become widespread due to the small volume of the joint, the close location to neurovascular bundles and the manipulation difficulty.
The aim of the study was to determine the safe zones for the minimally invasive approaches to the elbow in patients with lateral and medial epicondylitis.
Methods. A complex anatomical and clinical study was performed. The anatomical part was carried out on 30 non-fixed anatomical preparations of the upper limb. The features of the tendon-muscular and neurovascular structures surrounding the elbow were studied, depending on the angle of elbow flexion at three different levels: level I — 5 cm above the articular gap, level II — the articular gap, level III — the neck of the radius. In the clinical part of the study, the these structures were studied by MRI in 30 patients.
Results. The brachial artery at the level I is located from the bone at a distance 28.6 (28.4-28.7) mm at the elbow flexion to 90°. The radial nerve at level II is located at a distance of 15.8 (15.6-16.0) mm from the nominal medial epicondylar line (NMEL). From the NMEL the median nerve is located at a distance of 17.5 (16.6-18.1) mm, the brachial artery — 22.4 (20.5-22.8) mm. The anterior bundle of the medial collateral ligament has the following average width throughout: the proximal part — 6.2±1.4 mm; the middle part — 6.5±1.5 mm; the distal part — 9.3±1.4 mm. The average area of the medial collateral ligament attachment to the medial condyle of the humerus was 45.5±9.3 mm^2 and has a rounded shape. The average length of the radial collateral ligament was 20.5±1.9 mm; width — 5.2±0.8 mm, the average area of its attachment to the humerus was 13.6±1.4 mm^2. The average area of the extensor carpi radialis brevis on the lateral condyle of the humerus was 53.1±3.7 mm^2. The average distance from the entrance of the deep branch of the radial nerve into the supinator canal to the articular gap — 28 (25.5-29.6) mm.
Conclusion. The results of the study make it possible to choose the safe arthroscopic approaches to the elbow with minimal risk of damage to neurovascular structures in the treatment of patients with lateral and medial epicondylitis.

Keywords: medial epicondylitis, lateral epicondylitis, arthroscopy, supinator canal, surgical approach to the elbow joint.

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Безопасные артроскопические доступы к локтевому суставу при эпикондилитах: топографо-анатомическое обоснование

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Актуальность. Артроскопические методики диагностики и лечения заболеваний локтевого сустава пока не приобрели широкого распространения в связи с малым объемом сустава, близким расположением сосудисто-нервных структур и сложностью манипулирования.
Цель исследования — определение безопасных зон для формирования малоинвазивных доступов к локтевому суставу при лечении пациентов с латеральным и медиальным эпикондилитами.
Материал и методы. Выполнено комплексное топографо-анатомическое и клиническое исследование. Топографо-анатомическая часть проведена на 30 нефиксированных анатомических препаратах верхней конечности. Изучались особенности сухожильно-мышечных и сосудисто-нервных структур, окружающих локтевой сустав, в зависимости от угла сгибания в локтевом суставе на трех различных уровнях: I уровень — 5 см выше суставной щели, II уровень — суставная щель, III уровень — шейка лучевой кости. В клинической части исследования вышеописанные структуры изучались с помощью МРТ у 30 пациентов.
Результаты. Плечевая артерия на I уровне находится на расстоянии 28,6 (28,4–28,7) мм от кости при сгибании конечности в локтевом суставе до 90°. Лучевой нерв на II уровне находится на расстоянии 15,8 (15,6–16,0) мм от условной медиальной эпикондилярной линии (УМЭЛ). Срединный нерв расположен от УМЭЛ на расстоянии 17,5 (16,6–18,1) мм, а плечевая артерия — на 22,4 (20,5–22,8) мм. Передний пучок медиальной коллатеральной связки (МКС) имеет следующие средние значения ширины: проксимальная часть — 6,2±1,4 мм; средняя часть — 6,5±1,5 мм; дистальная часть — 9,3±1,4 мм. Средняя площадь прикрепления МКС к медиальному надмыщелку плечевой кости составляет 45,5±9,3 мм^2 и имеет округлую форму. Средняя длина лучевой коллатеральной связки — 20,5±1,9 мм; ширина — 5,2±0,8 мм, средняя площадь ее прикрепления на плечевой кости — 13,6±1,4 мм^2. Средняя площадь короткого лучевого разгибателя запястья на латеральном надмыщелке плечевой кости составляет 53,1±3,7 мм^2. Среднее расстояние от входа глубокой ветви лучевого нерва в супинаторный канал до суставной щели — 28 (25,5–29,6) мм.
Заключение. В результате исследования определены наиболее безопасные артроскопические доступы к локтевому суставу с минимальным риском повреждения сосудисто-нервных структур при лечении пациентов с латеральным и медиальным эпикондилитом.

Ключевые слова: медиальный эпикондилит, латеральный эпикондилит, артроскопия, канал супинатора, хирургические доступы к локтевому суставу.

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BACKGROUND

Incomplete satisfaction of patients with enthesopathies of the distal humerus with the results of open surgical treatment led to the development of minimally invasive techniques [1]. The difficulty of surgical treatment of this pathology is associated with the complexity of the anatomical structure and biomechanics of the elbow joint (LS), as well as with contractures and heterotypic ossifications developing in the postoperative period [2].

Arthroscopy of elbow joint allows not only to diagnose intraarticular changes, but also to simultaneously perform all the necessary medical manipulations [3]. At the same time, elbow joint arthroscopy is a complex procedure compared to arthroscopy of the knee and shoulder joints, which is due to the small volume of the joint, the close location of neurovascular structures and the technical complexity of the procedure [4]. Therefore, it has not been widely distributed. The share of arthroscopic procedures on elbow joint in the overall structure of arthroscopies is 11% [5].

To date, there are six generally accepted arthroscopic approaches to elbow joint, which have their advantages, disadvantages and risks of iatrogenic complications [3]. The risk of damage to neurovascular structures during elbow joint arthroscopy is up to 11.8% [4, 6]. A lot of studies have been carried out to examine the topographical and anatomical features of neurovascular structures in the area of elbow joint, as well as the risk of their injury by instruments inserted into the joint cavity through formed arthroscopic approaches [7, 8, 9]. There are isolated studies that investigate the degree of neurovascular structures displacement depending on the flexion angle in the elbow joint [10, 11]. Along with this, there are practically no studies of the topography of neurovascular structures in relation to arthroscopic treatment of patients with enthesopathies of the distal humerus [12]. Quite a lot of cadaveric studies have been carried out aimed at research of safe and effective arthroscopic approaches to elbow joint [5, 10, 11, 13].

The following arthroscopic approaches are most often used for the treatment of patients with pathology of elbow joint: proximal medial, anterolateral, proximal lateral and anteromedial, however, there are practically no publications devoted to justification of arthroscopic approaches to elbow joint safety in enthesopathies of the distal humerus [14, 15, 16].

The aim of the study was to determine the safest areas promising for the formation of minimally invasive approaches to the elbow joint in the treatment of patients with enthesopathies of the distal humerus.

METHODS

A two-center complex topographic anatomical and clinical study was performed.

Topographic anatomical study

Topographic anatomical study was performed on 30 unfixed human elbow joints cadaver specimens (16 women and 14 men) who died at the age of 22 to 65 years. The study did not include cadavers that were exposed to external influences (injuries, burns), as well as cadavers with diseases that cause destruction of the joint and articular surfaces.

The following parameters were studied:

1) topography and location of the main neurovascular structures in relation to adjacent bone structures, as well as changes in these parameters depending on the angle elbow joint flexion;

2) anatomical features and topography of the radial collateral and ulnar collateral ligaments and their relationship with the tendons of the extensor carpi radialis brevis (ECRB) and the flexor carpi ulnaris (FCU);

3) the area of ECRB and FCU tendons attachment to the distal humerus;

4) the location of the Frohse arcade (*canalis supinatorius*).

The first stage was to determine the shortest distance from the radial nerve to the humerus and radius and from the median nerve to the humerus and ulna with different functional positions of the elbow joint. Measurements were performed at three levels: level I — 5 cm above the articular gap; level II — at the level of the joint; level III — at the level of the radius neck (Fig. 1).

After dissection of the neurovascular bundle in the axilla, a subclavian single-channel catheter was inserted into the axillary artery, through which an oil suspension of lead whitewash was injected.

Radiopaque marks made of copper wire were stretched along the radial and median nerves, after which angiorentgenography of the elbow joint area was performed in AP and lateral projections in three functional positions: in 90°, 120° and 0° of flexion. According to the obtained images, the distance from the marked structures to the anterior border of the adjacent bone was measured in the lateral projection (Fig. 2).

Measurements were performed at levels I, II and III. Then the analysis of the obtained data was carried out in order to determine the position of the limb at which the studied distance was maximal. Using angiorentgenograms in AP projection at level II in the position of full extension, the distances from the conditional lateral epicondylar line (CLEL) to the radial nerve and from the conditional medial epicondylar line (CMEL) to the median nerve and brachial artery were studied (Fig. 3). This stage of the study was necessary to determine safe zones in which nerve-vascular structures injury is minimized, since level II is the most convenient for the location of arthroscopic approaches.

The next stage was to study individual characteristics, in particular, the variability of the anatomy, topography, and the mutual disposition of the tendon groups of the flexor and extensor muscles of the forearm. Particular attention was paid to the tendons most susceptible to degenerative changes in epicondylitis of the distal forearm. According to the literature, FCU, the pronator teres humeral head in medial epicondylitis and ECRB in lateral epicondylitis are most often affected [17, 18] (Fig. 4).

To determine the volume required for full-fledged resection of a degeneratively altered tendon, the areas of enthesis to the condyles of the humerus were determined. To perform this task, careful preparation of the studied tendons was carried out, followed by their cutting off from the humerus, morphometric measurements were performed and the area of the attachment zone was calculated using selected formulas.

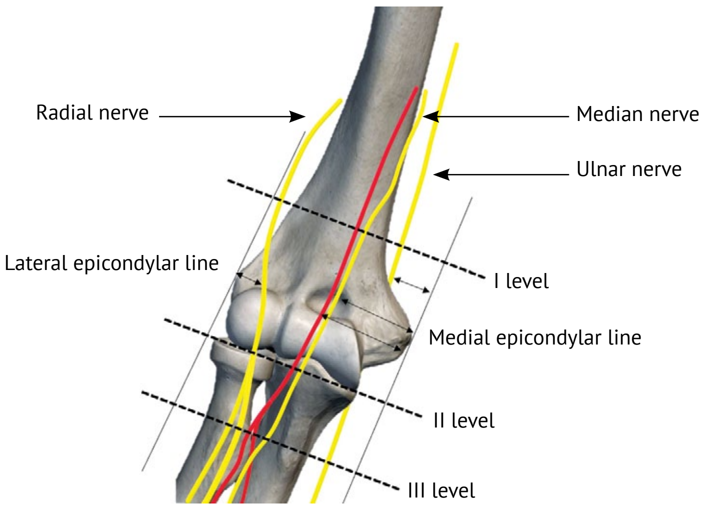

Fig. 1. Scheme of anatomical structures at three levels in the area of the elbow (front view)

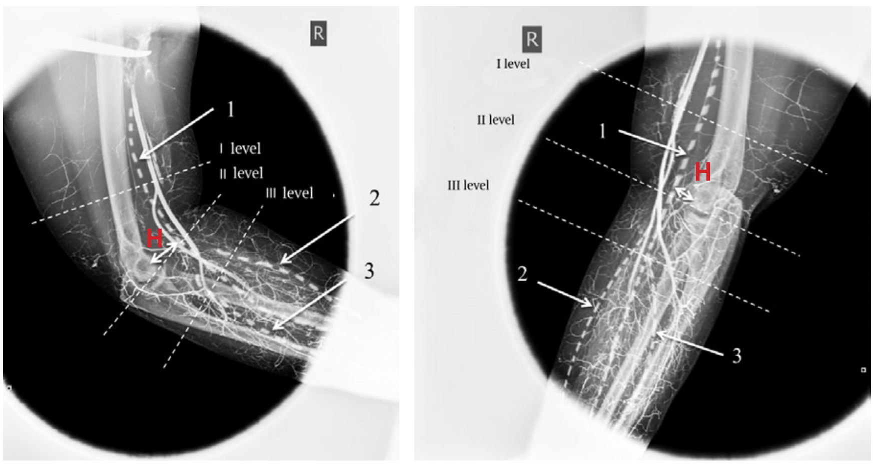

Fig. 2. Angiograms of the right elbow: a — lateral projection, flexion by 0º; b — lateral projection, flexion by 90º, where the arrrows indicate X-ray contrast marks: 1 — median nerve; 2 — superficial branch of the radial nerve; 3 — deep branch of the radial nerve; H — distance from brachial artery to the anterior surface of the humerus

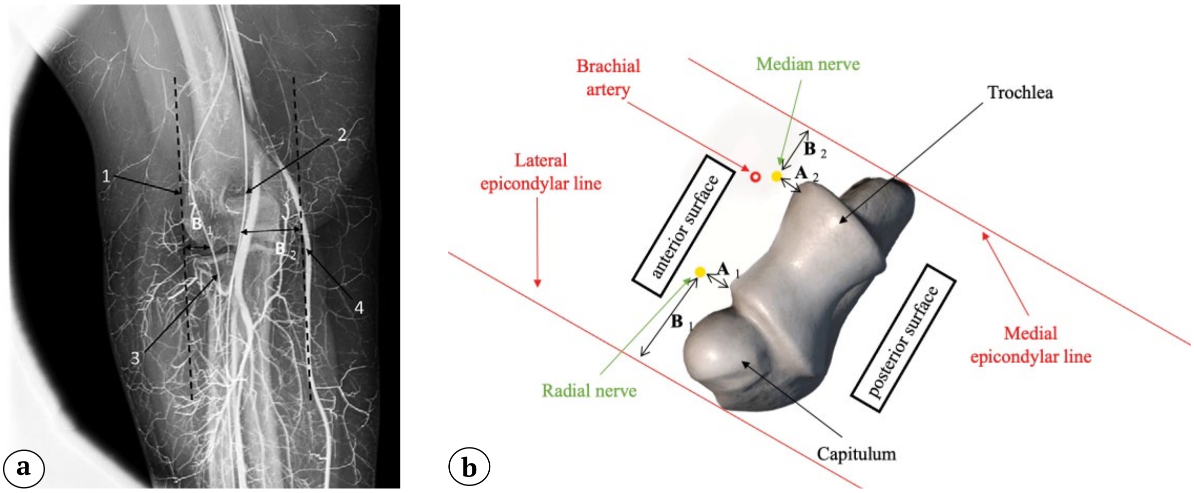

Fig. 3. Vascular and nerve structures at the elbow II level:
a — angiorentgenogram; b — schematic image; A_1 — the distance from the radial nerve to the humerus anterior surface; A_2 — from the median nerve to the humerus anterior surface; B_1 — from the radial nerve to the lateral epicondylar line; B_2 — from the median nerve to the medial epicondylar line; 1 — lateral epicondylar line; 2 — median nerve; 3 — radial nerve; 4 — medial epicondylar line

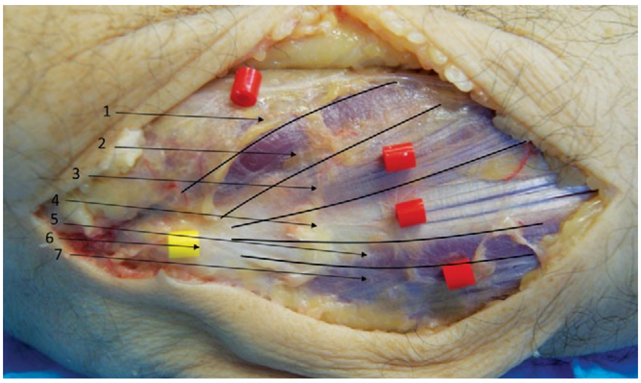

Fig. 4. Unfixed anatomical preparation of right elbow, view from the lateral surface of the forearm. Topography of the extensor tendons in the area of the lateral epicondyle of the humerus. Black lines marked to intermuscular borders:
1 — brachioradialis muscle; 2 — *extensor carpi radialis longus*; 3 — *extensor carpi radialis brevis*; 4 — *superficial extensor digitorum*; 5 — extensor of the little finger;
6 — lateral epicondyle of the humerus; 7 — *flexor carpi ulnaris*

Then we studied the supinator channel location — the so-called supinator arc, or Frohse arcade. To do this, the topographic area in the projection of the radial nerve was dissected on 30 macro-preparations from the level of the elbow joint articular gap to the entry of the radial nerve deep branchinto the supinator canal, followed by fixing this distance on each macro-preparation.

The results of the topographic anatomical study were recorded in the protocols. To preserve the actual material and the possibility of additional analysis, the main stages of the study were recorded using digital photography. To analyze the variability of the studied distances and their statistical analysis, the results of the protocols were entered into an Excel spreadsheet.

Clinical study

In the clinical part of the study, variants the neurovascular (brachial artery, ulnar, median, radial nerves) and tendon-muscle structures anatomy were studied by analyzing 30 magnetic resonance imaging scans of elbow joints performed on a Philips 3.0 T tomograph. MRI was performed on 16 men and 14 women with the initial stages of osteoarthritis, the average age was 44.0±6.3 years (from 21 to 67). The Dicom Viewer Radiant computer program (Medixant, Poland) was used to process the MRI data.

The distances from the radial and median nerves and the brachial artery to the anterior border of the humerus shadow were measured in axial projection on the MRI of the elbow joint at level II. Distances to CLEL and CMEL were also measured from the above-mentioned structures (Fig. 5).

The features of the topography and morphometric characteristics of the elbow joints ligaments, namely the radial collateral ligament (RCS) and the anterior bundle of the medial collateral ligament (ABMCL), were studied on tomograms in the coronary projection (Fig. 6). On tomograms in the sagittal projection, the sizes of the ECRB and FCU tendons attachment zones to the lateral and medial condyles of the humerus were studied.

Statistical analysis

Statistical data processing was carried out using the Past 306 program, followed by the construction of tables. The normality of the data distribution was evaluated using the Shapiro–Wilk criterion. For normally distributed indicators, the average values, standard deviation and 95% confidence interval are presented. The statistical significance of the differences in the mean values in the dependent samples was assessed using the Wilcoxon t-test of paired comparisons. The critical value was considered to be $p<0.05$. For indicators that are not normally distributed, descriptive characteristics were represented by the median and upper and lower quartiles (Q1-Q3).

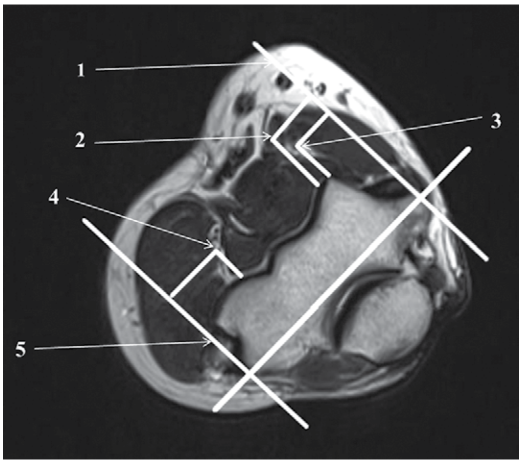

Fig. 5. MRI of the elbow joint, axial projection, where:
1 – medial epicondylar line; 2 — brachial artery;
3 — median nerve; 4 — radial nerve;
5 — lateral epicondylar line

RESULTS

Topographic-anatomical study results

The results of the first stage of the topographic anatomical study showed that when the upper limb is flexed in the elbow joint from 0° to 90°, the radial and median nerves are at the maximum distance from the bone structures, however, flexion up to 120 ° leads to a decrease in this distance (Tab. 1). Due to an increase in the maximum distance between the studied nerves and bone structures at levels II and III manipulations in elbow joint and approaches at these levels are safer than at level I.

Cadaveric X-ray angiographic studies of the brachial artery in the area of the elbow joint showed that in flexion up to 90°, the brachial artery moves away from the bone and is at the maximum distance at level I (Tab. 2).

Then the safe intervals of possible apprach displacement from the humerus condyles in the frontal plane at level II were determined, since this level is the most convenient for the release of injuried tendons. When studying the distances from the CLEL to the radial nerve and from the CLEL to the median nerve and brachial artery, angiorentgenograms at level II determined that the radial nerve is located at a distance of 15.8 (15.6-16.0) mm, the median nerve is 17.5 (16.6-18.1) mm away from the CLEL, and the brachial artery is 23.7 (20.5-22.8) mm.

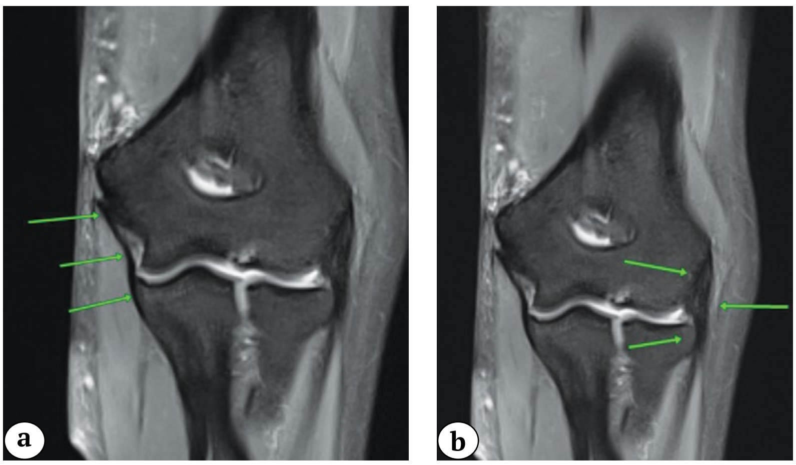

Fig. 6. MRI of the elbow, axial projection. Arrows indicate:
a — anterior bundle of the ulnar collateral ligament;
b — radial collateral ligament

Table 1

Distance from the anterior shadow of bone structures to peripheral nerves

Level	Nerve	Angle of elbow flexion, deg.	Me (Q_1–Q_3), mm
I	Radial	0	6,4 (6,2–6,6)
		90	7,8 (7,4–8,4)
		120	6,9 (6,7–7,1)
	Median	0	15,4 (15,2–16,0)
		90	16,2 (15,8–16,5)
		120	15,5 (15,3–16,2)
II	Radial	0	13,4 (13,1–13,7)
		90	16,4 (16,0–16,5)
		120	16,1 (15,7–16,2)
	Median	0	13 (12,6–13,5)
		90	21,8 (21,6–22,5)
		120	21,6 (21,4–22, 2)
III	Radial	0	9,7 (9,5–9,9)
		90	14,7 (14,3–15,2)
		120	14,6 (14,4–15,0)
	Median	0	6,4 (5,8–6,8)
		90	15,2 (14,9–15,6)
		120	14,9 (14,4–15,2)

Table 2

The distance from the brachial artery to the anterior shadow of the adjacent bone at three levels

Level	Angle of elbow flexion, deg.	Me (Q_1–Q_3), mm
I	0	26, 9 (26,6–27,2)
	90	28,6 (28,4–28,7)
	120	27,8 (27,7–28,1)
II	0	15,3 (15,2–15,4)
	90	16,8 (16,5–17,1)
	120	15,8 (15,6–16,0)
III	0	19,7 (19,5–19,9)
	90	21,4 (21,2–21,7)
	120	20,8 (20,7–21,0)

The most comfortable level to manipulate injuried tendons of the extensor and flexor muscle groups of the forearm is level II. The distances from the condyles to important neurovascular structures are determined:

1) for the lateral approach, the zone is located no more than 15 mm from the CLEL, with a displacement of more than 15 mm, the risk of injury to the radial nerve increases;

2) for the medial port, the zone is limited to 15 mm from the CMEL, with an increase in this distance, the risk of damage to the brachial artery and median nerve increases.

During the second stage, it was revealed that the average proximal width of the ABMCL is 6.2±1.4 (4.2-9.1) mm. The average width of the middle part is 6.5±1.5 (4.3-9.2) mm, the average distal width is 9.3±1.4 (6.2–13.5) mm. The average area of the zone of its attachment to the medial condyle of the humerus is 45.5±9.3 (25.9–59.4) mm^2 and had a rounded shape. In the area of the ulna (coronoid process), it has an oblong shape, the average area of attachment is 65.4 (54.3—78.6) mm^2, the total length of the ABMCL is 21.5 (20.0-23.0) mm.

The RCS is very closely adjacent to the ECRB tendon and is located above the middle humeroradial line of the joint, when attempting to release the RCS below this line, there is a high risk of damage to the RCS. The average total length of the RCS is 20.5±1.9 mm, the beam width of the RCS is 5.2±0.8 mm, the average total length is 44.6±1.9 mm. The average area of the RCS attachment zone on the humerus is 13.6 ± 1.4 mm^2.

The ECRB is located directly under the extensor carpi radialis longus (ECRL), and to reach this structure it is necessary to dissect or displace it. It was also found that the ECRB is adjacent directly to the anterior capsule of the elbow joint. The average area of the ECRB is shown in Table 3.

During the study of the ECRB tendon in the area of attachment to the humerus lateral condyle, it was revealed that this area has the rhomboid shape (Fig. 7).

The tendon part of the FCU is located above the middle humeroradial line, directly adjacent to the ABMCL, and when performing the FCU release below the middle humeroradial line, the probability of the medial collateral ligament injury increases. The average area of the FCU in the area of attachment to the humerus medial condyle is shown in Table 3.

Table 3

The area of tendons attachment to the humerus condyles at the II level

Tendon	M±SD, mm²
ECRB	53,1±3,7
FCR	58,3±6,3

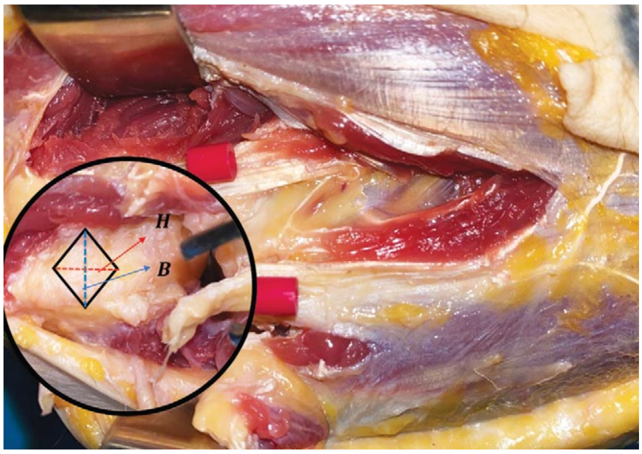

Fig. 7. Unfixed anatomical macropreparation of the right elbow. Attachment of *extensor carpi radialis brevis*, where the tendon is indicated by a rhombus, the blue arrow indicates the width, the red arrow — the height

During the study of flexor muscle group of the forearm tendons, namely the area of attachment of the FCU tendon to the medial condyle of the humerus, it was revealed that it has the shape of a circle (Fig. 8).

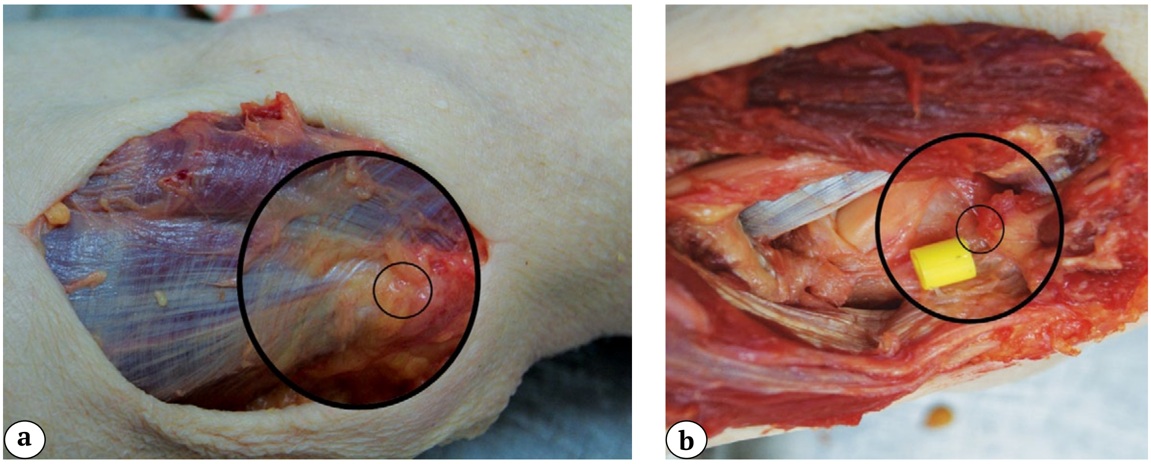

Fig. 8. Unfixed macropreparation of the left elbow. Measurement of the attachment of the tendon of the flexor carpi radialis of the left elbow joint, where the area of attachment of the flexor carpi radialis is marked by a circle a — the macropreparation of the tendons of the flexors of the left elbow joint, where the area of attachment of the radial flexor of the wrist is marked by a circle.
b — the macropreparation, a condition after exposure of the area of attachment of the tendon of the radial flexor of the wrist to the area of the medial condyle of the humerus (marked by a yellow label)

The median distance from the articular gap to the entrance of the deep motor branch of the radial nerve into the supinator canal was 28 (25.5-29.6) mm, which causes a high risk of damage to this structure manipulating in these areas.

Clinical study results

During the MRI examination of the elbow joint in axial projections at level II, the distances from the neurovascular structures (radial and median nerves, brachial artery) to the anterior border of the humerus shadow, as well as from the radial nerve to the CLEL and from the median nerve and brachial artery to the CMEL were measured (Tab. 4).

The results obtained were not have statically significant differences with the data obtained by analyzing angiorentgenograms in the topographic anatomical part of the study ($p>0.05$). The safe distance from the conditional epicondylar lines can be considered 16 mm versus 15 mm obtained by angiorentgenograms (Tab. 5).

Table 4

The distance from the neurovascular structures to the CLEL and CMEL at the II level with full extension of the upper limb

Structure	Level	Me (Q_1–Q_3), мм
Radial nerve	CLEL	17,6 (17,4–17,9)
Brachial artery	CMEL	22,8 (22,7–23,2)
Median nerve		18,8 (18,7–19,2)

Table 5

The distance from the neurovascular structures to the anterior surface of the humerus at level II with full extension of the upper limb according to anatomical examination and MRI, Me (Q1-Q3), mm

Structure	MRI	Anatomical
Radial nerve	12,8 (12,4–13,7)	13,4 (13,1–13,7)
Brachial artery	15,7 (15,7–15,9)	15,3 (15,2–15,4)
Median nerve	14,9 (14,3–15,8)	13 (12,6–13,5)

p>0,05.

In the final part of the clinical study, the length of the medial and radial collateral ligaments, as well as the area of their attachment zones, were determined. According to MRI data, the average length of ABMCL is 20.5 (19.6-23.5) mm. It is best visualized on MRI on frontal sections.

The average length of the RCS is 26.5 (24.7-28.7) mm. The revealed parameters of ligament length can be useful in cases of their iatrogenic injury during the release of damaged tendons.

Also, according to the MRI data, the average areas of the attachment zones were determined: the tendons of the ECRB — 52.4 mm^2, the FCU — 56.2 mm^2. The average width of the ECRB in the attachment area was 3.1 ±1.7 mm: in the middle part — 7.2±2.1 mm and in the distal part — 4.5±1.8 mm. The average width of the FCU in the attachment area was 4.3±1.3 mm: in the middle part — 8.1±2.3 mm and in the distal part — 5.7±2.1 mm. The results obtained have no statistically significant differences with the data obtained in the topographic anatomical part of the study (p>0.05).

DISCUSSION

The risk of neurovascular structures injury during arthroscopy of elbow joint is due to various factors: insufficient experience of the surgeon, poor knowledge of the neurovascular structures topography, the close location of nerves in the area of arthroscopic approach [20]. In arthroscopic treatment of lateral epicondylitis, the deep branch of the radial nerve, the medial cutaneous nerve of the forearm, the anterior interosseous nerve of the forearm, which is also a branch of the median nerve, are the most vulnerable to injury [21, 22]. The deep branch of the radial nerve and the anterior interosseous nerve are motor branches, when damaged, the functions of the hand are violated.

According to the results of our topographic anatomical study, the radial and median nerves are at the maximum distance from the bone structures at the angle of elbow joint flexion from 0 to 90 °, but further flexion leads to a decrease in the distance. According to C.D. Miller et al., the distance of the median and radial nerves from the bone is 12 and 6 mm, respectively in 90 ° flexion. It is worth noting that in their study, the authors used a saline solution for insufflation, which significantly increases the distance of the neurovascular structures to the bone, but they estimated the distance from the joint capsule to the nerve structures [10]. A similar study was performed by M. Hackl et al., who estimated the distance from the neurovascular structures to the bone during flexion in the elbow joint, as well as during 20 ml insufflation of saline solution into the joint [11].

In the Russian literature, we have not found reports of topographic anatomical studies devoted to determine safe zones for the arthroscopic approaches in the treatment of medial epicondylitis of the humerus. Previously, we performed a combined topographic anatomical and clinical study on 12 human elbow joints cadaver specimens to determine the structural features of the medial collateral ligament and safe arthroscopic ports when performing the release of elbow joint [23]. The results of this study showed that the safe zone for surgery is located above the midline of the humeroulnar joint by 2 (1.0-3.2) mm. In this zone, there is a minimal risk of damage to the ABMCL.

During the study of ABMCL, it was revealed that it has a dense location in relation to the FCR. The width of the ulnar collateral ligament was measured in three places. And these values are consistent with the values obtained in the studies of S. Floris with co-authorset al. [24], L.A. Timmerman et al. [25], W.D. Regan et al. [26] The measurements performed in this study showed that the width of the ligament is uneven, increases in the distal direction (to the place of attachment) to an average of 9.3 mm. There are no particular differences in the area of ligament attachment to the distal humerus, the results are similar [27]. The data obtained has great importance for the surgeon, because due to the topographic features during the release of the FCU, the ABMCL can be injuried. In case of injury to this structure by more than 50% (in the proximal part — more than 3.0 ± 1.4 mm, in the middle part of the ligament — 3.5 ±1.5 mm), the risk of valgus elbow joint instability development increases.

According to our data, the average area of attachment of ABMCL to the medial condyle of the humerus is 45.5±9.3 mm^2, which coincides with the results of the study by M.E. Cinque aet al. [28]. During the study of FCU, it was revealed that the average area of its attachment to the condyles of the humerus is 13.6 ±1.4 mm^2. This differs from the data presented by D. Berholt et al. – 7.1 mm2 [29].

According to the results of this study, the distance from the articular gap to the entrance of the deep motor branch of the radial nerve to the supinator arch is 28 (25.5–29.6) mm. Its injury is possible when an arthroscopic approach is performed 3 cm distal and 1 cm anteriorly from the lateral condyle of the humerus. The data obtained completely coincide with the results of the study by N.F. Hilgersom et al [21].

CONCLUSION

To perform approaches, the safest level for arthroscopic treatment of the distal humerus enthesopathy is level II. For arthroscopic release of ECRB, it is recommended to use a proximal medial approach 2.0 cm proximal and 0.5 cm anteriorly from the medial epicondyle of the humerus, and an anterolateral approach located 1.0 cm distal and 1.0 cm anteriorly from the lateral epicondyle of the humerus. For arthroscopic release of FCU, it is recommended to use an anterolateral approach located 1.0 cm distal and 1.0 cm anteriorly from the lateral condyle of the humerus, and anteromedial approach located 2.0 cm distal and 2.0 cm anteriorly from the medial condyle of the humerus.

DISCLAIMERS

Author contribution

All authors made equal contributions to the study and the publication.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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